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# Lignite Aquifers and Kidney Disease


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## INTRODUCTION

- A disease called BEN (Balkan endemic nephropathy).
- Chronic tubulointerstitial disease leading to end-stage renal failure.
- Often occurs in association with renal pelvic cancer (RPC).
- No cure; only treatment is dialysis or kidney transplant.
- Only occurs among people in rural villages without municipally treated water; private wells tap lignite aquifers.
- When villages develop municipal water supply, BEN disappears there.

Romanian BEN patient getting dialysis treatment.

## WHY IMPLICATE COAL?

- Pliocene lignites are geologically young and the most chemically reactive of all types of coal.
- BEN only occurs in areas with lignite deposits at certain elevations.
- Topography in these areas suggests that groundwater percolates through lignite and flows underground to well locations.
- No convincing data supporting genetic factors, infectious agents (exclusively), or other etiologies.
- Coal contains polycyclic aromatic hydrocarbons (PAH) among organic constituents.
- Some PAHs well known to cause cancer.

## HYPOTHESIS

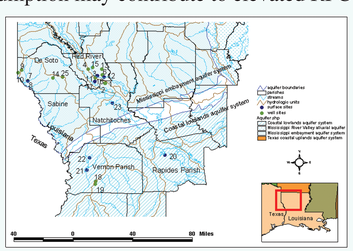
- Toxic organic compounds are leached out of low-rank lignite deposits into groundwater.
- Rural well owners ingest xenobiotics over decades and develop BEN/RPC.
- Possibility of other co-factors, immunomodulation, multiple causality.

## BEN IN THE USA?

- States with the highest incidence and mortality from renal pelvic cancers include: Wyoming (No. 1), North and South Dakota (Nos. 3 and 4), and Louisiana (No. 6).
- All of these states have large rural populations that use well water, and extensive lignite deposits (similar in rank to the Pliocene lignites linked to BEN).

## POSSIBLE CONTRIBUTING ROLE OF MICROBES

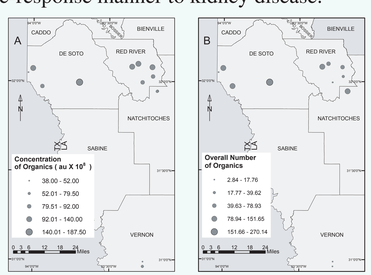
- In USA, better health care and standard of living may preclude frank BEN.
- Leptospira interrogans (bacteria that cause kidney disease) identified in 50% of Louisiana surface water sites in area where well water sampled.
- Fungi that produce kidney toxins found in Louisiana water samples
- Combined exposure to pathogens and lignite water consumption may contribute to elevated RPC rates.




Locations of water wells and surface water sites sampled for chemical analysis.

## EPIDEMIOLOGICAL EVIDENCE LINKING LIGNITE-DERIVED COMPOUNDS WITH RENAL PELVIC CANCER (RPC) IN NORTHWESTERN LOUISIANA

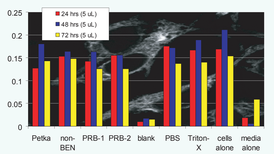
- In May and September, 2002, 14 private residential drinking water wells, one dewatering well at a lignite mine, eight surface water sites, and lignite from an active coal mine were sampled in five Parishes of northwestern Louisiana.
- Out of 89 environmental parameters tested, significant associations were found between RPC rate (data obtained from Louisiana Tumor Registry) and the presence in drinking water of organic compounds, the fungi Zygomycetes, $PO_4$, $NH_3$, and 13 chemical elements.
- Some organic compounds identified are structurally similar to analgesics, which cause BEN-like kidney disease.
- Of 13 inorganic elements significantly correlated with RPC incidence, only Li related in a positive dose-response manner to kidney disease.




Organic compounds measured in well water samples.

## TOXICOLOGICAL EXPERIMENTS: DOES LIGNITE WATER DAMAGE KIDNEY TISSUE?

- Human kidney cell cultures treated with organic fraction concentrated from well water samples.
- Initial results suggest concentration-dependent effect.
- Lower levels: cell proliferation (cancer).
- Higher levels: cell death (BEN).




Results of toxicological experiment on human kidney cells treated with organics concentrated from well water.

## FOR MORE INFORMATION

- http://pubs.usgs.gov/of/2003/of03-374/of03-374.pdf (Preliminary Geochemical, Microbiological, and Epidemiological Investigations into Possible Linkages between Lignite Aquifers, Pathogenic Microbes, and Kidney Disease in Northwestern Louisiana).
- http://pubs.usgs.gov/fs/fs004-01/fs004-01.pdf (Health Effects of Toxic Organic Compounds from Coal -- The Case of Balkan Endemic Nephropathy (BEN).

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